September 1972 B72-10593

NASA TECH BRIEF

Lewis Research Center

Fabrication of Cooled, Graphite-Lined Structures

A new method of fabricating cooled, graphite-lined structures has been developed and tested in a rocket engine thrust chamber.

One way to improve the performance of rocket engine thrust chambers is to design them to operate at very high temperatures, i.e., 2755 K (4500°F). The major problem involves selecting materials of construction which can withstand such temperatures, and which can be fabricated satisfactorily. One candidate material, graphite, has the ability to withstand operating temperatures greatly in excess of 2478 K (4000°F) (more than double the operating temperature of commonly used materials such as stainless steel or superalloys); however, most types of graphite are brittle and very susceptible to failure from factors such as thermal shock. Thus the graphite is employed as a liner within a metal jacket.

To prevent the metal jacket from overheating, the heat conducted through the wall of the graphite liner must be rapidly removed. To do this effectively, there must be full and intimate contact between the liner and the jacket, and passages within the liner for a circulating coolant. Machining the jacket to closely fit the contour of the liner is difficult and expensive.

An improved method of fabricating a cooled graphite-lined thrust chamber has been developed. A layer of nickel is electro-deposited onto the outer surface of the machined and contoured graphite liner. Coolant passages are then machined into this layer of nickel. The passages are filled with wax and the outer shell is electro-formed over this. The wax is removed by melting and then flushing with solvent. Manifolds are then welded on to complete the thrust chamber.

A thrust chamber fabricated in this fashion was tested in a flox/methane rocket engine with complete success. Operating conditions were a thrust of 22,250 N (5000 lb.), chamber pressure of 3.45×10^6 N/m^2 (500 psia), and a wall temperature of 2755 K (4500°F). Total operating time was 525 seconds. The test included a total of 21 starts; the longest single run was 220 seconds. A cycle test of eight cycles of 5 seconds on and 2 seconds off was also included. There was no damage to the graphite liner, and there was no measurable erosion.

This is the first known regeneratively cooled, graphite-lined thrust chamber that has been built and successfully tested. Extensions of this technology to other types of thrust chambers or heat exchangers can be made wherever the graphite is compatible with the environment in which it is operating.

Notes:

1. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $12.00
   (or microfiche $0.95)

   Reference: NASA CR-120853 (N72-24941), A Graphite-Lined Regeneratively Cooled Thrust Chamber
2. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10593

(continued overleaf)

Patent status:

NASA has decided not to apply for a patent.

Source: Rudolph A. Duscha
Lewis Research Center and
Vernon R. Stubbs of
Aerojet Liquid Rocket Co.
under contract to
Lewis Research Center
(LEW-11741)